

ORIGINAL ARTICLE

Appropriate use of personal protective equipment among healthcare workers in public sector hospitals and primary healthcare polyclinics during the SARS outbreak in Singapore

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Background: Singapore was affected by an outbreak of severe acute respiratory syndrome (SARS) from 25 February to 31 May 2003, with 238 probable cases and 33 deaths.

Aims: To study usage of personal protective equipment (PPE) among three groups of healthcare workers (HCWs: doctors, nurses, and administrative staff), to determine if the appropriate PPE were used by the different groups and to examine the factors that may determine inappropriate use.

Methods: A self-administered questionnaire survey of 14 554 HCWs in nine healthcare settings, which included tertiary care hospitals, community hospitals, and polyclinics, was carried out in May–July 2003. Only doctors, nurses, and clerical staff were selected for subsequent analysis.

Results: A total of 10 236 valid questionnaires were returned (70.3% response); 873 doctors, 4404 nurses, and 921 clerical staff were studied. A total of 32.5% of doctors, 48.7% of nurses, and 77.1% of the administrative staff agreed that paper and/or surgical masks were "useful in protecting from contracting SARS". Among this group, 23.6% of doctors and 42.3% of nurses reported working with SARS patients. The view that a paper and/or surgical mask was adequate protection against SARS was held by 33.3% of doctors and 55.9% of nurses working at the A&E unit, 30.5% of doctors and 49.4% of nurses from medical wards, and 27.5% of doctors and 37.1% of nurses from intensive care units. Factors which predicted for agreement that paper and/or surgical masks were protective against SARS, included HCW's job title, reported contact with SARS patients, area of work, and Impact Events Scale scores.

Conclusion: A variety of factors determine appropriate use of personal protective equipment by HCWs in the face of a major SARS outbreak.

Severe acute respiratory syndrome (SARS), a viral respiratory illness caused by the coronavirus, SARS-CoV, is possibly the first globally significant occupational disease to emerge in the 21st century. Corona viruses are single stranded RNA viruses causing disease in human and animals. Other known corona viruses have also been known to cause the common cold in humans. Most studies of SARS cases in which transmission occurred from a single point of exposure have reported an incubation period between 2 and 10 days.¹ SARS is an occupational disease which the world is beginning to come to grips with, and a grim reminder that healthcare work is potentially hazardous.² Those in direct contact with patients, especially involving aerosol generating procedures, were at highest risk.³ In some cases, transmission to healthcare workers (HCWs) occurred even when they were wearing masks, eye protection, gowns, and gloves.

The primary mode of transmission appears to be through direct or indirect contact of mucous membrane (eyes, nose, or mouth) with infectious respiratory droplets or fomites.³ Outbreaks involving large numbers of SARS patients have been linked to the use of aerosol generating procedures; for example, endotracheal intubation, bronchoscopy, and treatment using aerosolised medication.¹ The role of the faecal-oral route is unknown but may be important. Person-to-person spread by infected droplets is the most important mode of spread. When the infected person coughs, droplets containing the virus are released into the surroundings and

infect those around this sick person. This explains the spread of SARS to HCWs, and family members and friends which have been reported in many studies.^{4, 5}

The outbreak of SARS in Singapore was first reported on 12 March 2003 (<http://www.gov.sg/moh/sars/news/chronology.html>). The index patient was hospitalised at Tan Tock Seng Hospital (TTSH), which subsequently became the country's designated SARS hospital. This index patient infected 20 others (both patients and HCWs), who in turn became the secondary sources of spread of the infection. The last case of probable SARS occurred on 5 May 2003. There were a total of 238 SARS cases in Singapore from March to May 2003, with 33 deaths.⁶

In other occupational exposure, engineering measures (for example, enclosure, local exhaust ventilation, substitution, etc) could be adopted more easily. But for HCWs the most important means of protecting them against SARS is to equip them with personal protective equipment (PPE). Therefore the choice of PPE and their correct usage are of paramount importance.

The Ministry of Health (MOH), Singapore Manual for SARS Infection Control in Hospitals dated 26 April 2003 stated that "Personal protective equipment (PPE) including

Abbreviations: A&E, accident & emergency unit; HCW, healthcare worker; IES, Impact Events Scale; PAPR, powered air purifying respirator; PPE, personal protective equipment; SARS, severe acute respiratory syndrome

Main messages

- A variety of factors determine appropriate use of personal protective equipment by HCWs in the face of a major SARS outbreak.
- A sizable number of HCWs were not familiar with the protection levels of the different type of respiratory protection.

hand hygiene, gown, gloves, and N95 respirators in addition to eye protection are mandatory for health-care workers to prevent transmission of SARS in health-care settings". The Manual went on to further emphasise "the basic recommended protective attire for CONTACT WITH SARS SUSPECT OR SARS PROBABLE PATIENTS includes fit tested N95 respirators, goggles or face shields, disposable long sleeved gowns and disposable gloves".⁷ Based on the available literature, it is generally believed (if the PPE are correctly worn) that powered air purifying respirators (PAPR) offered the highest level of protection against infected aerosol of SARS patients followed by N95. Surgical masks may offer a certain level of protection, while paper masks generally offer little or no protection to the HCWs.⁸ Goggles protect the HCW against splashes of fluid from the SARS patients. Other protection included gloves, gowns, hair covers, and shoe covers.⁸

How closely are the MOH instructions being followed by the HCWs and what is their understanding of the protective nature of the PPE? It was with the above in mind that the study was conducted with the objectives: (1) to determine the use of PPE among three groups of HCWs (doctors, nurses, and clerical staff); (2) to determine if the correct PPE was being worn by each group; and (3) to examine the factors associated with incorrect PPE use.

METHODS

This paper reports the results for a subset of a larger study involving 15 025 HCWs employed in nine healthcare settings in the public sector, who were invited to participate in a self-administered anonymous questionnaire survey from May to July 2003. The healthcare settings included the three SARS affected tertiary hospitals, a non-affected hospital for women and children, two community hospitals, two dental centres (one of which was located within a SARS affected hospital), and nine primary care clinics belonging to one of two healthcare clusters in Singapore. The two dental centres are excluded in the present report. Furthermore, only doctors, nurses, and clerical staff (those least likely to be exposed to SARS) are included.

The questions were on occupational and sociodemographic data, perception of risk of infection and preventive measures, and the impact of the SARS outbreak on personal and work life. The responses were recorded on a six point Likert scale (1 = strongly disagree, 6 = strongly agree) with scores of 1–3 taken as indicative of negative response, and 4–6 as a positive response. Respondents also completed an abbreviated Impact of Event Scale (IES), which is a measure of stress reactions after a traumatic event.^{9–10} In our questionnaire, one question on the IES avoidance subscale ("My feelings about it were kind of numb") was inadvertently omitted, which resulted in an abbreviated IES score. Ethical approval was obtained from the Institutional Review Boards of the respective institutions.

The six page questionnaire was given to a designated coordinator from the Human Resource Department of the respective institution. The coordinator would then disseminate it to the respective departments in the institution. A

Policy implications

- It is important not only to emphasise the right respiratory protection to be used but also to ensure that what is being communicated is carried out by all levels of HCWs.

deadline was given for the return of the questionnaire. Participation was strictly voluntary and the responses anonymous. No additional attempts were made to get the individuals to respond when the deadline was passed. The study questionnaires were processed by an optical reader with pre-written editing programs.

Statistical analysis

We used SPSS version 11.5 (SPSS Inc, Chicago, USA) for the analysis of data. The questions beginning with a stem such as "I believe that the following measures are useful in protecting me from contracting SARS..." Individuals who agreed that paper and/or surgical masks were effective were grouped together as "agreed" for all subsequent analysis. In addition to univariate descriptive statistics, we performed multiple logistic regression to determine the significant factors that were associated with the view that usage of paper/surgical masks was protective against SARS.

Logistic regression analysis was used to evaluate significant factors predicting a response which agrees that paper and/or surgical masks were protective against SARS, adjusting for significant possible risk factors. Odds ratios and 95% confidence intervals (CI) were calculated, using the lowest risk group as the referent. The following variables were entered into the multiple logistic regression models: age, length of service, job title, nature of work, area of work, and IES scores.

RESULTS

The overall response rate was 70.3%. The response rates were much better in the community hospitals and the polyclinics compared with general hospitals (table 1). We were interested in how knowledgeable the doctors, nurses, and clerical staff in the various healthcare settings were with regard to the effectiveness of the different PPE. Table 2 shows the knowledge of effectiveness of PPE by doctors, nurses, and clerical staff. The types of PPE were grouped under respiratory and others, and within each group the PPE are ranked in descending order starting with the most effective.

A total of 10.2% of the doctors agreed that paper masks were protective, while 30.1% agreed that surgical masks were protective. The percentages for nurses were higher (34.9% and 52.1%, respectively), and for clerical staff, the highest (55.7% and 85.3%, respectively). In contrast, the responses from the other PPE (N95 mask, goggles, PAPR, gowns, hair cover, gloves) were fairly homogeneous among the three groups (table 2).

Individuals who agreed that paper and/or surgical masks were effective were grouped together as "agreed" for all

Table 1 Response rates by healthcare setting

Types of healthcare setting	No. of payroll staff	No. of valid returned questionnaires	Response rate (%)
General hospitals (4)	13389	9257	69.1
Polyclinics (9)	751	615	81.9
Community hospitals (2)	414	364	87.9

Table 2 Knowledge of effectiveness of personal protective equipment (PPE) by doctors, nurses, and clerical staff

Types of PPE	Doctors (n = 873)				Nurses (n = 4404)				Clerical staff (n = 921)			
	Agree*	(%)	Disagree†	(%)	Agree*	(%)	Disagree†	(%)	Agree*	(%)	Disagree†	(%)
PAPR	765	95.4	37	4.6	3910	97.0	119	3.0	615	90.6	64	9.4
N95 mask	849	99.5	4	0.5	4330	99.4	26	0.6	830	97.0	26	3.0
Surgical mask	250	30.1	581	69.9	2102	52.1	1930	47.9	699	85.3	120	14.7
Paper mask	84	10.2	739	89.8	1388	34.9	2585	65.1	423	55.7	336	44.3
Goggles	787	94.0	50	6.0	4169	97.6	102	2.4	648	89.6	75	10.4
Gloves	825	98.9	9	1.1	4280	99.4	24	0.6	713	95.4	34	4.6
Gowns	798	95.6	37	4.4	4268	98.9	48	1.1	686	94.5	40	5.5
Hair cover	692	84.3	129	15.7	3909	95.0	205	5.0	647	92.2	55	7.8

*Agree that the PPE is effective against contracting SARS.

†Disagree that the PPE is effective against contracting SARS.

PAPR, powered air purifying respirator.

subsequent analysis; 32.5% of doctors, 48.7% of nurses, and 77.1% of the clerical staff fell into this category. Of the HCWs who reported working with SARS patients, 23.6% of the doctors and 42.3% of the nurses felt that a paper and/or surgical mask was adequate protection against SARS. A total of 33.3% of the doctors and 55.9% of the nurses working at the accident & emergency unit (A&E), 30.5% of the doctors and 49.4% of the nurses working in medical wards, and 27.5% of the doctors and 37.1% of the nurses working in the intensive care unit felt that a paper and/or surgical mask was adequate protection against SARS (table 3).

Table 4 summarises the significant factors that were associated with individuals who agreed that a paper/surgical mask was adequate protection against SARS. The risk of using a less effective level of respiratory protection was lowest among doctors, followed by nurses and clerical staff. Individuals who (regularly) came into contact with SARS patients were more likely to wear the appropriate respiratory protection compared to those who did not. Using "administrative" staff as the reference group, individuals working in surgical, medical, and intensive care units were more likely to wear the appropriate respiratory protection. However, there was no significant difference for those individuals in the other areas (A&E, radiographic services, laboratory services, and others) compared to administrative personnel. Individuals with IES scores of ≥ 20 were more likely to wear a more effective respiratory protection than those with IES scores of ≤ 19 .

DISCUSSION

In the prevention of occupational disease, controlling the hazard at source is always the foremost guiding principle. HCWs come in contact with varied groups of people from all walks of life. It would be very difficult to apply this principle. Of course, healthcare institutions did set up other safeguards; for example, temperature screening for all individuals coming into the hospital, special protocols for managing febrile patients, isolation wards, respiratory isolation, and barrier precautions.¹¹⁻¹³ But ultimately, the last line of defence is the appropriate use of personal protective devices, especially that of an effective respiratory protection.

The questions asked to the participants on usage of PPE began with a stem "I believe that the following measures are useful in protecting me from contracting SARS..." The range of PPE available to HCWs which we studied is listed in table 2. Generally, more than 85% of the participants agreed that goggles, gowns, hair cover, and gloves were useful in protecting them from contracting SARS. With regard to respiratory protection (paper mask, surgical mask, and N95 mask), the responses were more varied; 10.2% and 34.9% of the doctors and nurses, respectively, agreed that a paper mask, and 30.1% and 52.1% of the doctors and nurses,

respectively, agreed that a surgical mask was protective against contracting SARS (table 2). Although we know much more about the nature of the virus and the mode of transmission, such was not the case during the outbreak and indeed not even during the time of the study. There was also some controversy as to what level of protection was "adequate". This controversy may have contributed in some ways to this finding.

Another possible reason for this finding could be the variable interpretation of this question by the respondents. Some respondents could have interpreted the statement "I believe that the following measures are useful in protecting me from contracting SARS" to mean that having these measures was *better* than not having any protection. Therefore, it would be "useful in protecting me from contracting SARS". However, if it was just an interpretational observation we would expect more respondents to agree and the distribution for agreeing to the different type of masks to be fairly similar across the three groups, which is not so (table 2). Of course, the belief that a paper/surgical mask may be adequate does not mean that such individuals would only use this level of protection. Also relevant may be the range of other measures in place, especially temperature screening and other control measures employed. These measures may give the confidence that things were under control.

Seto and colleagues¹⁴ conducted a case-control study with 241 non-infected and 13 infected staff in five Hong Kong hospitals. They reported that "staff who wore surgical masks and N95 masks were significantly associated with non-infection, but this was not seen for paper masks". Although this is a small study which may not be representative of the general population, it certainly points to the ineffectiveness of paper masks against SARS. Loeb and colleagues¹⁵ conducted a retrospective study among 43 critical care units with SARS patients in Toronto. They reported a "...near 80% reduction in risk of infection for nurses who consistently wore masks (either surgical or N95). ... compared with use of N95 to use of surgical masks, the relative SARS risk associated with the N95 mask was half that for the surgical mask." These papers suggest that surgical masks do provide some protection, but an N95 mask would give a higher protection. In fact, the US Centers for Disease Control and Prevention (CDC) report recommended "a respirator that is at least as protective as an N-95 respirator approved by the National Institute for Occupational Safety and Health (NIOSH)" for protection against SARS.⁸

It was for this reason that we combined individuals who agreed that a paper mask and/or surgical mask was protective against SARS into one category versus those who disagree that paper and surgical masks were protective. A total of 32.5% of doctors and 48.7% of nurses agreed that paper masks and/or surgical masks were protective against SARS.

Table 3 Basic characteristics of doctors, nurses, and clerical staff who agreed that paper and/or surgical masks are protective against SARS

	Doctors			Nurses			Clerical Staff		
	Total	Agreed	(%)	Total	Agreed	(%)	Total	Agreed	(%)
Types of institution									
General hospitals (4)	763	249	36.6	4043	1977	38.3	857	662	77.2
Polyclinics (9)	99	33	33.3	191	84	44.0	49	35	71.4
Community hospitals (2)	11	2	18.2	170	84	49.4	15	13	86.7
Nature of work									
SARS patients	233	55	23.6	1228	520	42.3	39	26	66.7
Non-SARS patients	770	218	28.3	3516	1697	48.3	250	187	74.8
Members of the public	365	97	26.6	1780	852	47.9	375	280	74.7
NA	22	9	40.9	73	53	72.6	374	297	79.4
Area of work									
Surgical discipline	271	70	25.8	803	387	48.2	23	17	73.9
Medical discipline	341	104	30.5	1219	602	49.4	48	34	70.8
ICU	40	11	27.5	496	184	37.1	8	5	62.5
A&E	42	14	33.3	93	52	55.9	32	25	78.1
Radiographic services	38	9	23.7	16	9	56.3	8	6	75.0
Laboratory services	22	11	50.0	4	3	75.0	38	33	86.8
Administrative	3	–	–	35	17	48.6	577	459	79.5
Others	86	26	30.2	1412	730	51.7	142	99	69.7
Nationality									
Local	744	208	28.0	3011	1408	46.8 ⁺	892	694	77.8
Foreign staff	124	41	33.1	1376	731	53.1	27	15	55.6
Mean age (y)									
	–	35.8	–	–	34.6	–	–	38.4	–
Mean length of experience (y)									
	–	11.4	–	–	12.8	–	–	7.6	–
Gender									
Male	509	154	30.3	146	67	45.9	76	60	78.9
Female	358	97	27.1	4244	2071	48.8	842	649	77.1
Ethnic group									
Chinese	709	202	28.5	2339	1004	42.9	414	327	79.0
Malay	7	1	14.3	618	329	53.2	250	198	79.2
Indian	89	24	27.0	548	255	46.5	209	153	73.2
Filipino	20	7	35.0	755	478	63.3	16	8	50.0
Others	42	17	40.5	92	49	53.3	24	18	75.0
Mean IES score									
Intrusive	–	7.8	–	–	9.5	–	–	7.3	–
Avoidance	–	7.3	–	–	11.2	–	–	10.3	–

Among the staff who agreed, 23.6% of the doctors and 42.3% of the nurses reported that their work “involves daily contact with SARS patients”. Even in high risk areas such as the A&E and medical units, at least a quarter of the doctors and nurses agreed that paper and/or surgical masks were adequate protection.

The A&E unit, being the first stop for possible SARS patients, would be the unit most at risk. Patients with fever would generally be admitted to a medical unit. It would have been better if staff managing these units used a more effective respirator. On a more positive note, individuals who had higher probability of coming in contact with SARS were more likely to wear effective respirators compared to the administrative staff (table 4). This observation showed that knowledge of a possible exposure risk, assuming that administrative work carries the least likely exposure to SARS, is more likely to help an individual make a better choice.

The IES is a self-report scale that assesses two categories of cognitive responses to stressful events: intrusion (intrusively experienced ideas, images, feelings, or bad dreams), and avoidance (consciously recognised avoidance of certain ideas, feelings, or situations). The scale was originally developed to assess current distress associated with a specific trauma.⁹ However, studies have reported that IES is also a valid measure of post-traumatic stress disorders.¹⁰ It is interesting

to note that individuals with mean IES scores of ≥ 20 are more likely to disagree that paper and/or surgical masks are protective against SARS. In this case it would imply that individuals who felt more stressed, with a heightened level of anxiety, were more likely to be vigilant and opt for a higher level of protection.

HCWs caring for patients with SARS or other types of infectious diseases which can be transmitted from direct patient contact or contact with large respiratory droplets in the close vicinity of an infected person patient should be properly trained in the correct use and removal of PPE, and reminded of the importance of hand hygiene. There have been reports of clusters of SARS cases among protected HCWs.¹⁶ Some of the reasons cited for these cases were: “no formal respiratory protection programme existed”, “individual workers had not been fit tested”, “mask did not fit well”, and “lacked a clear understanding of how best to remove PPE without contaminating themselves”.¹⁶

There may be a gap between knowledge and practice. HCWs may not be aware that the N95 mask should be used rather than paper and/or surgical masks. This study was carried out in May–July 2003. The N95 mask was the recommended mask for HCWs who may come in contact with SARS. In fact, the Ministry of Health, Singapore Manual for SARS Infection Control in Hospitals, dated 26 April 2003

Table 4 Significant factors predicting a response which agrees that paper and/or surgical masks are protective against SARS

	OR*	95% CI
Age (years)	1.013	1.003 to 1.024
Length of service (years)	0.984	0.974 to 0.994
Job title		
Clerical staff	1	
Doctor	0.127	0.090 to 0.181
Nurses	0.330	0.238 to 0.459
Nature of work		
Not in contact with SARS patients	1	
In contact with SARS patients	0.673	0.587 to 0.771
Area of work		
Administrative	1	
Surgical	0.570	0.385 to 0.845
Medical	0.635	0.431 to 0.934
Intensive care unit	0.378	0.249 to 0.574
A&E	0.837	0.514 to 1.364
Radiographic services	0.622	0.316 to 1.224
Laboratory services	1.542	0.727 to 3.267
Others	0.726	0.498 to 1.059
Impact Events Scale (IES) scores		
IES ≤ 19	1	
IES ≥ 20	0.866	0.769 to 0.974

*Odds ratios derived using a multiple logistic regression model adjusting for age, length of service, job title, nature of work, area of work, and IES scores, where applicable.

stated: "...the Ministry of Health recommends the use of N95 or equivalent respirators/masks" and "the N95 respirator or equivalent mask must be used according to manufacturer's instructions and fitted so that there is a proper seal between the masks sealing surface and the wearer's face".⁷ In spite of all the reminders, there is still a sizable number of HCWs who may be ignorant of this. Perhaps there should be a more concerted effort to pass information down the line. Different groups of individuals may not be getting the necessary information or may not understand the message.

During the SARS outbreak, some of the health institutions did not have enough N95 masks to supply all staff. The supply did not meet the unexpected huge demand, especially during the first few weeks. It was very difficult to get supplies of N95 masks. Hence, some hospitals had to prioritise and stratify who should receive them, according to level of risk. Those not in direct patient contact were only supplied with paper/surgical masks, while reserving the N95 masks for those during direct patient care. This practice may have also contributed to the study findings.

This misinformation or communication breakdown can be observed in this study. The doctors know more than the nurses, and the nurses more than the clerical staff. In situations where the individual could be at risk of infection, there must be a clear instruction as to what is expected of him/her, and he/she must carry it out. There must be checks and balances in place to ensure that what is expected is being carried out completely and correctly. Otherwise, HCWs run the risk of being infected.¹³

Conclusion

A variety of factors determine appropriate use of personal protective equipment by HCWs in the face of a major SARS outbreak. This study also highlights the importance of not only emphasising the right respirators to be used, but also the need to ensure that what is being communicated is carried out by all levels of HCWs.

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REFERENCES

- 1 Peiris JS, Yuen KY, Osterhaus AD, *et al.* The severe acute respiratory syndrome. *N Engl J Med* 2003;**349**:2381-2.
- 2 Koh D, Lim MK, Chia SE. SARS: health care work can be hazardous to health. *Occup Med (Lond)* 2003;**53**:241-3.
- 3 World Health Organisation. Consensus document on the epidemiology of severe acute respiratory syndrome (SARS), <http://www.who.int/csr/sars/en/WHOconsensus.pdf> 2003 (accessed 13 August 2004).
- 4 Hsu LY, Lee CC, Green JA, *et al.* Severe acute respiratory syndrome (SARS) in Singapore: clinical features of index patient and initial contacts. *Emerg Infect Dis* 2003;**9**:713-17.
- 5 Abdullah AS, Tomlinson B, Cockram CS, *et al.* Lessons from the severe acute respiratory syndrome outbreak in Hong Kong. *Emerg Infect Dis* 2003;**9**:1042-5.
- 6 Singapore Government. SARS website: www.sars.gov.sg (accessed 13 August 2004).
- 7 Ministry of Health (MOH), Singapore. Manual for SARS infection control in hospitals, <http://www.moh.gov.sg/corp/sars/information/healthcare.html> April 2003 (accessed 13 August 2004).
- 8 CDC. Understanding respiratory protection against SARS. Atlanta, GA: Center for Disease Control and Prevention, July 2003, <http://www.cdc.gov/niosh/nppt/respirators/respsars.html> (accessed 13 August 2004).
- 9 Horowitz M, Wilner N, Alvarez W. Impact of Event Scale: a measure of subjective stress. *Psychosom Med* 1979;**41**:209-18.
- 10 Sundin EC, Horowitz MJ. Impact of Event Scale: psychometric properties. *Br J Psychiatry* 2002;**180**:205-9.
- 11 Ho AS, Sung JJ, Chan-Yeung M. An outbreak of severe acute respiratory syndrome among hospital workers in a community hospital in Hong Kong. *Ann Intern Med* 2003;**139**:564-7.
- 12 Dwosh HA, Hong HH, Austgarden D, *et al.* Identification and containment of an outbreak of SARS in a community hospital. *CMAJ* 2003;**168**:1415-20.
- 13 Fisher DA, Chew MH, Lim YT, *et al.* Preventing local transmission of SARS: lessons from Singapore. *Med J Aust* 2003;**178**:555-8.
- 14 Seto WH, Tsang D, Yung RW, *et al.* Effectiveness of precautions against droplets and contact in prevention of nosocomial transmission of severe acute respiratory syndrome (SARS). *Lancet* 2003;**361**:1519-20.
- 15 Loeb M, McGeer A, Henry B, *et al.* SARS among critical care nurses, Toronto. *Emerg Infect Dis* 2004;**10**:251-5.
- 16 Ofner M, Lem M, Sarwal S, *et al.* Cluster of severe acute respiratory syndrome cases among protected health-care workers—Toronto, Canada. Centers for Disease Control and Prevention. *Morbidity Mortal Wkly Rep (MMWR)* 2003;**52**:433-6.